

CLAIMS

1. A multi-carrier CDMA communication apparatus comprising a transmitter and a receiver which perform transfer of data, using a multi-carrier CDMA method,
5 said transmitter having
 signal modulation units for the number of sub-carrier groups, which perform frequency spreading for each sub-carrier signal of each channel constituting a sub-carrier group, based on a predetermined condition; and
10 time spreading units for the number of sub-carrier groups, which multiplex all signals after the modulation processing and the frequency spreading for each sub-carrier signal, and perform time spreading with respect to the multiplexed signals for each sub-carrier signal, and
15 said receiver having
 time despreading units for the number of sub-carrier groups, which perform time despreading for each sub-carrier signal; and
 signal demodulation units for the number of
20 sub-carrier groups, which perform frequency despreading for each sub-carrier signal after the time despreading.
2. A multi-carrier CDMA communication apparatus comprising a transmitter and a receiver which perform transfer of data, using a multi-carrier CDMA method,

said transmitter having

a setting unit which sets a code rate of error correction, number of sub-carrier groups, frequency spreading rate, number of code multiplexes of frequency spreading code, frequency spreading code, time spreading rate, number of code multiplexes of time spreading code and time spreading code;

signal modulation units for the number of sub-carrier groups which perform frequency spreading for each 10 sub-carrier signal of each channel constituting a sub-carrier group, based on the set conditions; and

time spreading units for the number of sub-carrier groups, which multiplex all the signals after the modulation processing and the frequency spreading for each sub-carrier signal, and perform time spreading with respect to the multiplexed signals for each sub-carrier signal, and

said receiver having

time despreading units for the number of sub-carrier groups, which perform time despreading for each sub-carrier signal; and

signal demodulation units for the number of sub-carrier groups, which perform frequency despread ing for each sub-carrier signal after the time despread ing.

25 3. The multi-carrier CDMA communication apparatus

according to any one of claims 1 and 2, said signal modulation unit comprising:

a frame creation unit which creates data frames comprising a known sequence, frame information and data,
5 for each sub-carrier group based on said conditions;

a copy unit which generates data frames by the number of sub-carriers, by copying the data frame;

an information modulation unit which performs modulation processing with respect to the each data frame;

10 a frequency spreading unit which performs frequency spreading with respect to each sub-carrier signal after modulation, based on said conditions; and

15 a power control unit which performs transmission power control with respect to each sub-carrier signal after the frequency spreading.

4. The multi-carrier CDMA communication apparatus according to claim 2, wherein said setting unit sets the code rate of error correction, based on an input signal power
20 to interference power ratio transmitted from said receiver;
and

when there is no frequency spreading code to be allocated, at the time of setting the frequency spreading code and the time spreading code, said setting unit ensures
25 an allocatable frequency spreading code by reducing the

frequency spreading rate.

5. The multi-carrier CDMA communication apparatus according to claim 2, wherein said setting unit sets the
5 code rate of error correction, based on an input signal power to interference power ratio transmitted from said receiver; and

when there is no frequency spreading code to be allocated, at the time of setting the frequency spreading code, said setting unit ensures an allocatable frequency spreading code by reducing the frequency spreading rate, and

when the code rate cannot be set even in this condition, said setting unit ensures an allocatable frequency spreading code, by ensuring a plurality of frequency spreading codes in the same sub-carrier group.

6. The multi-carrier CDMA communication apparatus according to claim 5, wherein said setting unit allocates
20 the frequency spreading code, by leaving a predetermined frequency interval, while keeping the orthogonality and hierarchical relationship between frequency spreading codes.

25 7. The multi-carrier CDMA communication apparatus

according to any one of claims 1 and 2, said signal demodulation unit comprising:

a frequency despreading unit which performs frequency despreading for each the sub-carrier signal;

5 a synchronization detector which performs transmission line estimation for each sub-carrier signal after the frequency inverse conversion, based on the known sequence added to the data frame, calculates an absolute value and a complex conjugate of the transmission line
10 estimation results, normalizes the complex conjugate by the absolute value, weights the sub-carrier signal by the normalization result, and outputs the absolute value and the sub-carrier signal after weighting as an output;

15 a combining unit which generates a signal for the sub-carrier group by adding the all sub-carrier signals after weighting, and combines an absolute value for the sub-carrier group by adding the all absolute values; and

20 a path combining unit which multiplies the sub-carrier group signal corresponding to each path by the absolute value of the respectively corresponding sub-carrier group, to thereby generate a sub-carrier group signal after path combining, by adding all the multiplication results.

8. The multi-carrier CDMA communication apparatus
25 according to any one of claims 1 and 2, said signal

demodulation unit comprising:

a frequency despreading unit which performs frequency despreading in a unit of the sub-carrier signal;

5 a synchronization detector which performs transmission line estimation for each sub-carrier signal after the frequency inverse conversion, based on the known sequence added to the data frame, calculates a complex conjugate of the transmission line estimation results, weights the sub-carrier signal by said complex conjugate, 10 and outputs the sub-carrier signal after weighting as an output;

a combining unit which generates a signal for the sub-carrier group by adding all the sub-carrier signals after weighting; and

15 a path combining unit which adds all the sub-carrier group signals corresponding to each path, to thereby generate a sub-carrier group signal after path combining.

9. The multi-carrier CDMA communication apparatus
20 according to any one of claims 1 and 2, said signal demodulation unit comprising:

a frequency despreading unit which performs frequency despreading in a unit of the sub-carrier signal;

25 a synchronization detector which performs transmission line estimation for each sub-carrier signal

after the frequency inverse conversion, based on the known sequence added to the data frame, calculates an absolute value and a complex conjugate of the transmission line estimation results, normalizes the complex conjugate by the
5 absolute value, weights the sub-carrier signal by the normalization result, and on the other hand, estimates an interference power for each sub-carrier signal after the frequency inverse conversion based on the known sequence, and divides the sub-carrier signal after weighting by the
10 interference power;

a combining unit which generates a signal for the sub-carrier group by adding all the sub-carrier signals after the synchronization detection, and generates an absolute value for the sub-carrier group by adding all the absolute
15 values; and

a path combining unit which multiplies the sub-carrier group signal corresponding to each path by the absolute value of the respectively corresponding sub-carrier group, to thereby generate a sub-carrier group signal after path
20 combining, by adding all the multiplication results.

10. The multi-carrier CDMA communication apparatus according to any one of claims 1 and 2, said signal demodulation unit comprising:

25 a frequency despreading unit which performs frequency

despread in a unit of the sub-carrier signal;

a synchronization detector which performs transmission line estimation for each sub-carrier signal after the frequency inverse conversion, based on the known sequence added to the data frame, calculates a complex conjugate of the transmission line estimation results, weights the sub-carrier signal by the complex conjugate, estimates an interference power for each sub-carrier signal after the frequency inverse conversion based on the known sequence, and divides the sub-carrier signal after weighting by the interference power;

a combining unit which generates a signal for the sub-carrier group by adding all the sub-carrier signals after the synchronization detection; and

a path combining unit which adds all the sub-carrier group signals corresponding to each path, to thereby generate a sub-carrier group signal after path combining.

11. A multi-carrier CDMA communication apparatus comprising a transmitter and a receiver which perform transfer of data, using a multi-carrier CDMA method,

said transmitter having signal modulation units for the number of sub-carrier groups, which perform frequency spreading and time spreading for each sub-carrier signal of each channel constituting a sub-carrier group, based on

a predetermined condition; and

 said receiver having signal demodulation units for
the number of sub-carrier groups, which perform time
despreading and frequency despreading for each sub-carrier
5 signal.

12. A multi-carrier CDMA communication apparatus
comprising a transmitter and a receiver which perform
transfer of data, using a multi-carrier CDMA method,

10 said transmitter having

 a setting unit which sets a code rate of error
correction, number of sub-carrier groups, frequency
spreading rate, number of code multiplexes of frequency
spreading code, frequency spreading code, time spreading
15 rate, number of code multiplexes of time spreading code and
time spreading code;

 signal modulation units for the number of sub-carrier
groups which perform frequency spreading and time spreading
for each sub-carrier signal of each channel constituting
20 a sub-carrier group, based on the set conditions, and

 said receiver having signal demodulation units for
the number of sub-carrier groups, which perform time
despreading and frequency despreading for each sub-carrier
signal.

13. The multi-carrier CDMA communication apparatus according to any one of claims 11 and 12, said signal modulation unit comprising:

a frame creation unit which creates data frames
5 comprising a known sequence, frame information and data, for each sub-carrier group based on said conditions;

a copy unit which generates data frames by the number of sub-carriers, by copying the data frame;

an information modulation unit which performs
10 modulation processing with respect to each of the data frame;

a frequency spreading unit which performs frequency spreading with respect to each sub-carrier signal after modulation, based on said conditions;

15 a power control unit which performs transmission power control with respect to each sub-carrier signal after the frequency spreading; and

a time spreading unit which performs time spreading with respect to each sub-carrier signal after the frequency spreading.

20

14. The multi-carrier CDMA communication apparatus according to claim 12, wherein said setting unit sets the code rate of error correction, based on an input signal power to interference power ratio transmitted from said receiver,

25 and

when there is no frequency spreading code nor time spreading code to be allocated, at the time of setting the frequency spreading code and the time spreading code, said setting unit ensures an allocatable frequency spreading code
5 by reducing the frequency spreading rate.

15. The multi-carrier CDMA communication apparatus according to claim 12, wherein said setting unit sets the code rate of error correction, based on an input signal power
10 to interference power ratio transmitted from said receiver, and

when there is no frequency spreading code nor time spreading code to be allocated, at the time of setting the frequency spreading code and the time spreading code, said
15 setting unit ensures an allocatable frequency spreading code by reducing the frequency spreading rate, and

even in this condition, when there is still no frequency spreading code nor time spreading code to be allocated, said setting unit ensures an allocatable frequency spreading code,
20 by ensuring a plurality of frequency spreading codes in the same sub-carrier group.

16. The multi-carrier CDMA communication apparatus according to claim 12, wherein said setting unit sets the
25 code rate of error correction, based on an input signal power

to interference power ratio transmitted from said receiver,
and

when there is no frequency spreading code nor time
spreading code to be allocated, at the time of setting the
5 frequency spreading code and the time spreading code, said
setting unit ensures an allocatable frequency spreading code
by reducing the frequency spreading rate;

even in this condition, when there is still no frequency
spreading code nor time spreading code to be allocated, said
10 setting unit ensures allocatable frequency spreading code,
by ensuring a plurality of frequency spreading codes in the
same sub-carrier group; and

even in this condition, when there is still no frequency
spreading code nor time spreading code to be allocated, said
15 setting unit ensures allocatable frequency spreading code
and time spreading code, by ensuring a plurality of frequency
spreading codes in the same sub-carrier group, and increasing
the number of multiplexes of the time spreading code.

20 17. The multi-carrier CDMA communication apparatus
according to claim 12, wherein said setting unit sets the
code rate of error correction, based on an input signal power
to interference power ratio transmitted from the receiver,
and

25 when there is no frequency spreading code nor time

spreading code to be allocated, at the time of setting the frequency spreading code and the time spreading code, said setting unit ensures an allocatable frequency spreading code by reducing the frequency spreading rate;

5 even in this condition, when there is still no frequency spreading code nor time spreading code to be allocated, said setting unit ensures allocatable frequency spreading code, by ensuring a plurality of frequency spreading codes in the same sub-carrier group; and

10 even in this condition, when there is still no frequency spreading code nor time spreading code to be allocated, said setting unit ensures allocatable frequency spreading code and time spreading code, by ensuring a plurality of frequency spreading codes in the same sub-carrier group, and decreasing
15 the time spreading rate.

18. The multi-carrier CDMA communication apparatus according to any one of claims 11 and 12, said signal demodulation unit comprising:

20 a time despreading unit which performs time despreading in a unit of the sub-carrier signal;

a frequency despreading unit which performs frequency despreading in a unit of the sub-carrier signal;

25 a synchronization detector which performs transmission line estimation for each sub-carrier signal

after the frequency inverse conversion, based on the known sequence added to the data frame, calculates an absolute value and a complex conjugate of the transmission line estimation results, normalizes the complex conjugate by the

5 absolute value, weights the sub-carrier signal by the normalization result, and outputs the absolute value and the sub-carrier signal after weighting as an output;

a combining unit which generates a signal for the sub-carrier group by adding all the sub-carrier signals after 10 weighting, and combines an absolute value for the sub-carrier group by adding all the absolute values; and

a path combining unit which multiplies the sub-carrier group signal corresponding to each path by the absolute value of the respectively corresponding sub-carrier group, to 15 thereby generate a sub-carrier group signal after path combining, by adding all the multiplication results.

19. The multi-carrier CDMA communication apparatus according to any one of claims 11 and 12, said signal 20 demodulation unit comprising:

a time despreading unit which performs time despreading in a unit of the sub-carrier signal;

a frequency despreading unit which performs frequency despreading in a unit of the sub-carrier signal;

25 a synchronization detector which performs

transmission line estimation for each sub-carrier signal after the frequency inverse conversion, based on the known sequence added to the data frame, calculates a complex conjugate of the transmission line estimation results,
5 weights the sub-carrier signal by the complex conjugate, and outputs the sub-carrier signal after weighting as an output;

a combining unit which generates a signal for the sub-carrier group by adding all the sub-carrier signals after
10 weighting; and

a path combining unit which adds all the sub-carrier group signals corresponding to each path, to thereby generate a sub-carrier group signal after path combining.

15 20. The multi-carrier CDMA communication apparatus according to any one of claims 11 and 12, said signal demodulation unit comprising:

a time despreading unit which performs time despreading in a unit of the sub-carrier signal;

20 a frequency despreading unit which performs frequency despreading in a unit of the sub-carrier signal;

a synchronization detector which performs transmission line estimation for each sub-carrier signal after the frequency inverse conversion, based on the known sequence added to the data frame, calculates an absolute
25

value and a complex conjugate of the transmission line estimation results, normalizes the complex conjugate by the absolute value, weights the sub-carrier signal by the normalization result, and on the other hand, estimates an 5 interference power for each sub-carrier signal after the frequency inverse conversion based on the known sequence, and divides the sub-carrier signal after weighting by the interference power;

a combining unit which generates a signal for the 10 sub-carrier group by adding all the sub-carrier signals after the synchronization detection, and generates an absolute value for the sub-carrier group by adding all the absolute values; and

a path combining unit which multiplies the sub-carrier 15 group signal corresponding to each path by the absolute value of the respectively corresponding sub-carrier group, to thereby generate a sub-carrier group signal after path combining, by adding all the multiplication results.

20 21. The multi-carrier CDMA communication apparatus according to any one of claims 11 and 12, said signal demodulation unit comprising:

a time despreading unit which performs time despreading in a unit of the sub-carrier signal;

25 a frequency despreading unit which performs frequency

despread in a unit of the sub-carrier signal;

a synchronization detector which performs transmission line estimation for each sub-carrier signal after the frequency inverse conversion, based on the known sequence added to the data frame, calculates a complex conjugate of the transmission line estimation results, weights the sub-carrier signal by the complex conjugate, and on the other hand, estimates an interference power for each sub-carrier signal after the frequency inverse conversion based on the known sequence, and divides the sub-carrier signal after weighting by the interference power;

a combining unit which generates a signal for the sub-carrier group by adding all the sub-carrier signals after the synchronization detection; and

a path combining unit which adds all the sub-carrier group signals corresponding to each path, to thereby generate a sub-carrier group signal after path combining.

20 22. A multi-carrier CDMA transmitter which transmits data, using the multi-carrier CDMA method, said transmitter comprising:

signal modulation units for the number of sub-carrier groups, which perform frequency spreading for each 25 sub-carrier signal of each channel constituting a

sub-carrier group, based on a predetermined condition; and

time spreading units for the number of sub-carrier groups, which multiplex all the signals after the modulation processing and the frequency spreading for each sub-carrier

5 signal, and perform time spreading with respect to the multiplexed signals for each sub-carrier signal.

23. A multi-carrier CDMA transmitter which transmits data, using the multi-carrier CDMA method, said transmitter
10 comprising:

a setting unit which sets a code rate of error correction, number of sub-carrier groups, frequency spreading rate, number of code multiplexes of frequency spreading code, frequency spreading code, time spreading rate, number of code multiplexes of time spreading code and
15 time spreading code;

signal modulation units for the number of sub-carrier groups which perform frequency spreading for each sub-carrier signal of each channel constituting a
20 sub-carrier group, based on the set conditions; and

time spreading units for the number of sub-carrier groups, which multiplex all the signals after the modulation processing and the frequency spreading for each sub-carrier signal, and perform time spreading with respect to the
25 multiplexed signals for each sub-carrier signal.

24. A multi-carrier CDMA transmitter which transmits data, using the multi-carrier CDMA method, said transmitter comprising:

5 signal modulation units for the number of sub-carrier groups, which perform frequency spreading and time spreading for each sub-carrier signal of each channel constituting a sub-carrier group, based on a predetermined condition.

10 25. A multi-carrier CDMA transmitter which transmits data, using the multi-carrier CDMA method, said transmitter comprising:

a setting unit which sets a code rate of error correction, number of sub-carrier groups, frequency spreading rate, number of code multiplexes of frequency spreading code, frequency spreading code, time spreading rate, number of code multiplexes of time spreading code and time spreading code;

20 signal modulation units for the number of sub-carrier groups which perform frequency spreading and time spreading for each sub-carrier signal of each channel constituting a sub-carrier group, based on the set conditions.

25 26. A multi-carrier CDMA receiver which receives data, using the multi-carrier CDMA method, said receiver

comprising:

time despreading units for the number of sub-carrier groups, which perform time despreading for each sub-carrier signal; and

5 signal demodulation units for the number of sub-carrier groups, which perform frequency despreading for each sub-carrier signal after the time despreading.

27. A multi-carrier CDMA receiver which receives data,
10 using the multi-carrier CDMA method, said receiver comprising:

signal demodulation units for the number of sub-carrier groups, which perform time despreading and frequency despreading for each sub-carrier signal.